

Table 1

	C	Si	Mn	P	S	Cu	Ni	Cr	Crack percentage (N=100)
JIS S48C	0.45~0.51	0.15~0.35	0.60~0.90	0.03 or less	0.035 or less	0.30 or less	0.20 or less	0.35 or less	20%
Mn reduced	↑	↑	0.55~0.65	↑	↑	↑	↑	↑	12%
Mn, C reduced	0.45~0.48	↑	0.55~0.65	↑	↑	↑	↑	↑	5%
Mn, C reduced Inclusions reduced	0.45~0.48	0.14 or less	0.55~0.65	0.015 or less	0.015 or less	0.15 or less	↑	↑	0%

Table 2

Material	Process	Crack confirmation test	
		Upsetting test	Crankshaft formation
R material	Cutting→Acid pickling→Spherodizing annealing →Shot blasting +Bonderizing	8/10=80%	10/10=100%
Controlled rolling material	Cutting→Acid pickling→Spherodizing annealing →Shot blasting +Bonderizing	5/25=20%	2/30=7%
R material	Acid pickling→Spherodizing annealing→Acid pickling, Bonderizing→Drawing, Acid pickling→Spherodizing annealing→Shot blasting+Bonderizing	0/30=0%	0/30=0%
Controlled rolling material	Acid pickling→Spherodizing annealing→Acid pickling, Bonderizing→Drawing, Acid pickling→Spherodizing annealing→Shot blasting+Bonderizing	0/30=0%	0/30=0%
Surface-hardened steel (present invention)	Cutting→Acid pickling→Spherodizing annealing →Shot blasting+Bonderizing	0/20=0%	0/30=0%

Table 3

Component	C	Si	Mn	P	S	Cu	Ni	Cr
Proportion (wt %)	0.46~0.48	0.14 or less	0.55~0.65	0.015 or less	0.015 or less	0.15 or less	0.2 or less	0.35 or less

Table 4

No	Aging time (300°C)
A	No aging
B	0.5H
C	1.0H
D	1.5H
E	2.0H
F	2.5H
G	4.0H(Over Aging)

Table 5

No	Hardness(HRC)			d value (A)
	Before aging	After aging	(Internal)	
A	23.3			2.0291
B	22.8	23.1	23.7	2.0300
C	23.4	23.6	24.5	2.0308
D	23.2	23.8	24.8	2.0308
E	23.4	23.9	24.5	2.0317
F	22.9	23.8	24.7	2.0300
G	23.4	23.7	24.4	2.0308

Table 6

Point	No1	No2	No3
1	23.9	23.5	23.4
2	23.4	23.4	23.8
3	23.7	23.0	23.2
4	23.5	23.4	23.4
Average	23.6	23.3	23.4

Table 7

Point	No1		No2		No3	
	Surface	Internal	Surface	Internal	Surface	Internal
①	24.1	25.4	26.4	22.5	26.6	22.4
②	—	27.8	—	24.6	—	23.4
③	25.4	26.0	25.5	25.4	25.7	25.9
④	23.5	24.6	23.6	25.2	22.9	24.6
⑤	23.8	25.4	22.8	25.2	23.6	25.6
⑥	23.1	25.4	23.8	25.0	24.2	25.7
⑦	23.2	25.7	23.3	25.2	23.4	25.6
Average	23.9	25.8	24.2	24.7	24.4	24.7